THE EFFECT OF VIBRATION AND NOISE ON THE MENTAL FACULTY OF MAN UNDER TIME STRESS

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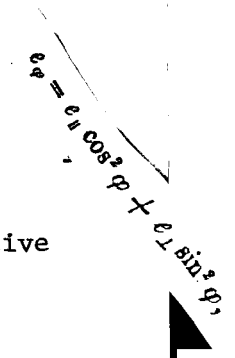
ABSTRACT. Experiments were made to study on 60 examinees in the age group of 25-45 years the effect of vibration and noise on the mental capacity of man under time stress. Prior to, during, and upon termination of the vibration effects the persons under examination did addition and substraction of the numbers presented at varying speed by following the procedure of "continuous counting at a given rate".

Investigations demonstrated that the influence of total vertical vibrations at a frequency of 70 cycles per second and an amplitude of 0.4 mm, generated by a vibration testing unit B11-70, reduces on the average as much as 1.5-2 times the qualitiative accomplishment of the experimental task. The effect of noise at 90 decibels cuts the qualitative accomplishment of the task on the average in half. The deepest and most persistent reduction of the mental efficiency is caused by the action of a complex irritant -- "vibration and noise".

The reduction of mental efficiency is the greater, the greater the time stress.



Vibration and noise having different parameters are unfavorable factors encountered in flight.

A large group of special studies have shown that vibrations have a negative influence upon the human body, and under certain conditions may lead to so-called vibration sickness (Ye. I. Andreyeva-Galanina).

There are comparatively few studies in aviation and cosmonautics devoted to the influence of vibration (N. N. Gurovskiy, V. G. Terent'yev, I. Ya. Borshchevskiy, with co-workers; Jacobs, et al.).

As a rule, these studies investigated the reaction of the cardiovascular, respiratory, and nervous system. A comparatively small number of studies have been devoted to the influence of vibration on the mental faculty of man (N. N. Gurovskiy, A. A. Koreshkov, et al.).

The mental condition under the complex conditions of space flight, or flight in an airplane, determines the final result of the mission as a whole.

We set ourselves the problem of analyzing the influence of vibration and noise on the mental faculty of man under conditions of a forced work rate. This

*Note: Numbers in the margin indicate pagination in the original foreign text.

is of interest, since there are contradictory data in the literature on this problem. As a rule, a study has also been made of those forms of mental activity which are not controlled by the time factor, which can have a significant influence upon the research results, since the time factor is of great importance in organizing the different compensatory mechanisms of the body.

In our experiments, this organization was practically excluded, since the /80
testees had no recourse to additional, duplicate means of qualitatively fulfilling the task, and thus disguising any changes in the higher cortical functions. The rate at which the problems were presented was dictated by the experiment conditions, and was always maintained at the boundary of the initial conceptual possibilities.

The studies were performed under laboratory conditions on 60 healthy individuals in the age group of 25-45 years. A VP-70 vibrating stand was used as the source of vibration. It produced a vertically directed vibration having a sinusoidal form lasting for one moment.

The platform of the stand held a flight seat with handles and two steps to support the feet. In every case, the testees were subjected to vibration having a frequency of 70 cps and an amplitude of 0.4 mm for 45 minutes.

The mental faculty was tested by the method of "continuous counting at a given rate", which reproduces the most important characteristics of the cosmonauts' activity during the most important periods of the flight: its high rate and continuous nature. When fulfilling the experimental test at a high rate, the testee was in a situation similar to that which could occur in certain portions of space flight.

The method of "continuous counting at a given rate" was used to perform the study before, during, and upon termination of the vibrations.

In order to compare the results, a control group (10 men) was compiled, whose composition was similar to the basic group. These men fulfilled the task of "continuous counting" in the same order, but without the influence of vibration.

It was found as a result of the study that the mental productivity, when the task was fulfilled based on the method of "continuous counting at a given rate", was reduced in varying degrees in all the testees under the influence of vibration having these parameters. This reduction was particularly apparent when the vibrating stand was switched on and in the first 5-7 minutes of its action. In this period, the testees made the most amount of errors, which entailed incorrectly changing from one work method to another, and incorrect counting of numbers.

The errors then gradually became smaller, which was probably related to adaptation to the vibration factor. However, there was a certain amount of errors throughout the entire period of vibration and even after it was terminated.

Immediately after the vibration was terminated, the mental faculty was

reduced in the absolute majority of cases (37), and only in three testees was it rapidly restored to its initial level.

If we compare results derived from a change in the mental faculty of people of different ages, it is found that in older people these changes are noted more frequently, are more extensive, and more persistent. This was particularly apparent in the group of testees ranging between 36-40 years and over (see the table).

As may be seen from the table, during the period of vibration, the most clearly expressed reduction in work productivity occurred in the testees. It was reduced by more than half in one-third of the cases.

An analysis of the errors entailed when continuously counting under vibration conditions shows that in half of the cases the errors were related to the incorrect changing from one work method to another. In the other half of the cases, the errors were related to a disturbance of the operative memory.

After the vibration had terminated, two-thirds of all the errors were caused by a reduction in the operative memory; one-third of all the errors were caused by changing their attention incorrectly. A large number of the errors related to the reduction of the operative memory results from the onset of fatigue. /81

The operation of the VP-70 vibrating stand was accompanied by the generation of engine noise. Therefore, a complex irritation consisting of vibration and noise (90 db) influenced the testees.

In order to determine the separate influence of vibration and noise, additional tests were performed, consisting of four stages. The first stage was to examine them without the influence of any of the factors, based on a method which we employed. The second method was to examine them when they were influenced only by the noise from the engine of the vibrating stand (the testee was placed alongside the vibrating stand). The third stage was to investigate them under vibration and noise conditions, and the fourth stage was to investigate them immediately after the vibrating stand was turned off, i.e., after the vibration had terminated.

The results of the study show that the mental faculty is reduced on the average by 50%, as compared with the initial data, under the influence of noise alone. Under the complex influence of vibration and noise, this reduction amounted to 150-200% on the average, and was persistent. In the first few minutes after the complex irritation (vibration and noise) had terminated, the initial productivity was not completely restored, although there was a certain improvement in the quality of the work.

Thus, the influence of a complex irritant causes more extensive and persistent changes in the mental faculty than the influence of noise alone. If it is assumed that the reduction is 100% under the influence of the complex irritation, then about 70% is due to the influence of vibration, and 30% is due to noise.

Consequently, vibration is the stronger component in the complex "vibration-noise" irritation.

RESEARCH RESULTS BASED ON THE "CONTINUOUS COUNTING AT A GIVEN RATE" METHOD UNDER THE INFLUENCE OF VIBRATION, AND AFTER IT WAS TERMINATED (IN % OF THE INITIAL INDICES)

Age Group	Number of men in group	During Vibration			After Termination of Vibration			
		Deterioration (up to 100)	Deterioration (110-200)	Deterioration more than 200	No change	Deterioration (up to 100)	Deterioration (110-200)	Deterioration 200 and more
Up to 30 years	17	4	8	5	2	10	5	-
31-35	9	2	5	2	1	6	2	-
36-40	8	1	4	3	-	3	3	2
More than 40 years	6	-	3	3	-	2	2	2
Total.....	40	7	20	13	3	21	12	4

However, a very important and unexpected finding was the fact that vibration causes significant and persistent disturbances of the mental activity, which in every case were more extensive than would be expected according to data given in the literature. The reduction in mental productivity was 1 1/2-2 times in all men belonging to the basic group, under the complex influence of the vibration-noise factor. This definitely indicates that it has a negative influence upon mental activity. This was corrorborated by the statistical processing of the research results. /82

A comparison of the results produced by individuals in the basic group and the control group when performing an experimental task shows that in the first group the successful completion of the work was significantly reduced under the influence of vibration. However, in the second group it was progressively increased.

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